

WHAT IS CLAIMED IS:

1. A supercharging device for supercharging intake air in an intake passage of an internal combustion engine based on a required intake air flow rate of the engine, the device comprising:

a positive-displacement supercharger disposed in the intake passage;

an electric motor driving the supercharger in response to a supplied electric power, the electric motor functioning as a generator when a rotational energy is input from the supercharger;

a bypass passage bypassing the supercharger and connecting an upstream portion and a downstream portion of the intake passage;

a bypass valve which opens and closes the bypass passage; and

a programmable controller programmed to:

calculate a discharge flow rate of the supercharger; and

regulate an opening of the bypass valve based on the discharge flow rate of the supercharger and the required intake air flow rate of the engine.

2. The supercharging device as defined in Claim 1, wherein the controller is further programmed to drive the supercharger by supplying electric power to the electric motor to supercharge intake air in the intake passage when the required intake air flow rate of the engine is greater than a predetermined threshold value, and cause the electric motor/generator to generate electric power by a rotational energy input from the supercharger which rotates according to an air flow in the intake passage when the required intake air flow rate of the engine is not greater than the threshold value.

3. The supercharging device as defined in Claim 2, wherein the controller is further programmed to close the bypass valve when the required intake air flow rate of the engine is greater than the threshold value.

4. The supercharging device as defined in Claim 2, wherein the controller is further programmed to increase the opening of the bypass valve as a difference between the discharge flow rate of the supercharger and the required intake air flow rate of the engine increases, when the required intake air flow rate of the engine is not greater than the threshold value.

5. The supercharging device as defined in Claim 2, wherein the controller is further programmed to open the bypass valve to a larger degree in a case where the required intake air flow rate of the engine is not greater than the discharge flow rate of the supercharger, than in a case where the required intake air flow rate of the engine is greater than the discharge flow rate of the supercharger.

6. The supercharging device as defined in Claim 2, wherein the device further comprises a throttle provided in the intake passage downstream of the supercharger, and the bypass passage is configured to branch off from the intake passage upstream of the supercharger and join the intake passage upstream of the throttle.

7. The supercharging device as defined in Claim 6, wherein the controller is further programmed to open the throttle larger than an opening corresponding to the required intake air flow rate of the engine when the required intake air flow rate of

the engine is not smaller than the discharge flow rate of the supercharger.

8. The supercharging device as defined in Claim 6, wherein the controller is further programmed to control the throttle to an opening corresponding to the required intake air flow rate of the engine when the required intake air flow rate of the engine is smaller than the discharge flow rate of the supercharger.

9. The supercharging device as defined in Claim 1, wherein the device further comprises a sensor which detects a rotation speed of the supercharger, a sensor which detects a pressure of the intake passage upstream of the supercharger and a sensor which detects a temperature of the intake passage upstream of the supercharger, and the controller is further programmed to calculate the discharge flow rate of the supercharger based on the temperature and the pressure of the intake passage upstream of the supercharger and the rotation speed of the supercharger.

10. The supercharging device as defined in Claim 1, wherein the device is adapted for use with an engine for a vehicle having an accelerator pedal, the device further comprises a sensor which detects a depression amount of the accelerator pedal, and the controller is further programmed to calculate the required intake air flow rate of the engine based on the depression amount of the acceleration pedal.

11. A supercharging device for supercharging intake air in an intake passage of an internal combustion engine based on a required intake air flow rate of the engine, the device comprising:

a positive-displacement supercharger disposed in the intake passage;

an electric motor driving the supercharger in response to a supplied electric power, the electric motor functioning as a generator when a rotational energy is input from the supercharger;

a bypass passage bypassing the supercharger and connecting an upstream portion and a downstream portion of the intake passage;

a bypass valve which opens and closes the bypass passage;

means for determining a discharge flow rate of the supercharger; and

means for regulating an opening of the bypass valve based on the discharge flow rate of the supercharger and the required intake air flow rate of the engine.

12. A control method for a supercharging device for supercharging intake air in an intake passage of an internal combustion engine based on a required intake air flow rate of the engine, the device comprising a positive-displacement supercharger disposed in the intake passage, an electric motor driving the supercharger in response to a supplied electric power, the electric motor functioning as a generator when a rotational energy is input from the supercharger, a bypass passage bypassing the supercharger and connecting an upstream portion and a downstream portion of the intake passage, and a bypass valve which opens and closes the bypass passage, the method comprising:

determining a discharge flow rate of the supercharger; and

regulating an opening of the bypass valve based on the discharge flow rate of the supercharger and the required intake air flow rate of the engine.